2015 State of Our Harbors

An Examination of Massachusetts Coastal Harbor Conditions and Related Economic Parameters

July 2016

Project No. P14-2882-D04 (3958-S)

Prepared by the Urban Harbors Institute, University of Massachusetts Boston and

Apex Companies, LLC

for the Massachusetts Department of Conservation and Recreation Division of Waterways

dcr Massachusetts

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APEX

ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

The Massachusetts Department of Conservation and Recreation (DCR) contracted Apex Companies, LLC from its Master Agreement List for Waterways Division Engineering Services to carry out tasks under Project Number P14-2882-D04 (3958-S). The Urban Harbors Institute, University of Massachusetts Boston, as subcontractor to Apex, led the development of the 2015 State of Our Harbors Report, the purpose of which was to assess the status of dredging within the coastal harbors of the Commonwealth of Massachusetts and estimate the costs and benefits of dredging to the Commonwealth and its coastal communities.

There are 204 harbors[1] along the coast of Massachusetts located within 73 municipalities. These harbors have significant economic, cultural, and recreational importance and support a variety of uses including boating, shipping, commercial and recreational fishing, swimming, and transportation (e.g., ferries and cruise ships). The size and scale of harbors within Massachusetts vary and include large centers of shipping, such as Boston and New Bedford, as well as much smaller harbors dominated by recreational boating, such as Cohasset and Marblehead. A number of harbors serve the essential needs of government agencies, such as the United States Coast Guard.

While the scale of activity and the specific uses of each vary, many Massachusetts' coastal harbors experience shoaling and sediment build-up, resulting in the need for dredging to maintain navigable depths in channels and mooring/anchorage areas. Though dredging is also done for environmental (water quality) improvement or remediation purposes, this report focuses on public dredging in support of water-dependent uses.

Dredging within Massachusetts is currently funded through a variety of entities, including the U.S. Army Corps of Engineers; the Environmental Protection Agency; state agencies including the Executive Office of Energy and Environmental Affairs, the Department of Conservation and Recreation, the Department of Environmental Protection, and the Seaport Economic Council; and municipalities. While a variety of entities are dedicated to supporting dredging activities within Massachusetts coastal waters, the needs significantly outweigh the funds available. Because of this, sufficient financial support to address dredging needs continues to be a major concern among Massachusetts harbormasters, municipal and state agencies, and those utilizing these waterways for recreational and commercial activities.

The purpose of this study was to collect and present information, from surveys and existing sources, about (1) public dredging activity in the coastal harbors of Massachusetts, with a focus on past, current, and future navigational dredging projects, and (2) state, municipal, and corporate revenue generated by activities associated with dredged waterways (e.g., the sale of fuel, boats, and other boating-related goods and services). This study also provides detailed information specific to each coastal harbor in Massachusetts, identifying unique features and traits including the facilities and activities that operate within those harbors.

Harbormasters from nearly all Massachusetts coastal municipalities provided their input on public dredging needs within their harbors, including the impacts of future dredging activities. Harbormasters participated through in-person or telephone interviews and through an online

[1] This number, 204, reflects municipal jurisdictions within harbors, meaning that each town's portion of a shared harbor was counted as a separate harbor. Ignoring municipal jurisdictions, there are a total of 164 harbors.

survey developed by the Center for Survey Research at the University of Massachusetts Boston[2]. State, county, and federal databases also provided data on past dredging projects in Massachusetts. This study also used economic data from the Massachusetts Division of Marine Fisheries, the United States Census Bureau, the National Oceanic and Atmospheric Administration's Economics National Ocean Watch (ENOW) program, and the National Ocean Economics Program (NOEP) to document the economic significance of harbor-related activities.

Note that the dredging needs and associated community impacts identified in this report are based on the results of a survey of harbormasters and, as such, are primarily the professional opinions of the harbormasters.

Key findings from the study include:

(1) The cost of public dredging needs exceeds available resources. Based on the significant need for dredging and associated costs, funding of dredging projects should be a priority for Massachusetts.

The current spending on public dredge projects is insufficient to address needs within Massachusetts. Massachusetts harbormasters identified 236 public areas in Massachusetts coastal harbors in need of dredging, which include harbor channels, anchorages, and mooring areas.[3] Study results estimate that the cost of public navigational dredging projects needed over the next ten years is approximately $288 million. This is an underestimation due to the fact that cost estimates for approximately one-third of the projects were either unknown or not available, and could not be estimated given the wide variability in the cost of dredging projects.[4] Additionally, this does not include the costs of private facilities that need dredging such as marinas and yacht clubs, nor the economic benefits (cost savings) to private marine facilities when they are able to "piggy-back" on a public navigational dredging project.

In Massachusetts, the federal, state, and municipal governments are typically investing approximately $7.4 million on public navigational dredge projects each year[5]. This current rate of funding represents only 26 percent of the known amount needed to complete the dredging projects identified in the next ten years. If information was available for the projects whose costs are not known, that percentage would be even lower.

The largest amount of funding for dredging comes from the federal government; however there has been an appreciable downward trend in the availability of these funds. The U.S. Army Corps of Engineers has the responsibility for maintaining authorized navigation projects in the state using appropriations from the Harbor Maintenance Trust Fund. Increasingly, these monies are

[2] See Appendix B for a list of harbors represented in the survey results.

[3] Some Massachusetts harbormasters also provided information on private dredging projects (e.g., dredging needed by marinas and yacht clubs). The private projects are not included in the 236 public areas in need of dredging, but they are included in the ArcGIS layer of approximate dredged areas and the harbor summary pages in Appendix A.

[4] Fuel prices can affect the cost per cubic yard of dredging. This estimate is based on current dredging prices provided by either harbormasters or state agencies.

[5] This estimate was based on dredging investments between 2010 and 2014, and does not include (1) the forthcoming dredging of Boston Harbor, (2) port-improvement projects for purposes other than navigation, (3) environmental remediation projects such as the estimated $400 million effort to clean-up New Bedford Harbor, or (4) projects in 2015/2016.

available only to ports and harbors through which large quantities of waterborne cargos move. Consequently, the state, ports, and municipalities must provide the funds needed to maintain and potentially enhance navigable waterways in Massachusetts.

(2) The economic importance of ocean-related industries justifies continued investment in dredging.

In 2014, the state and coastal municipalities collected an estimated $237,632,857 from taxes and fees related to the use of coastal waterways (e.g., slip and mooring fees, boat excise taxes). Comparing this number to the average annual dredging investment in Massachusetts for public projects (approximately $7,351,703), the estimated ratio of revenue to investment is approximately 32:1. **NOTE**: This estimate *only* includes direct revenue generated by the state and municipalities through taxes and fees related to the use of coastal waterways. It does not include the direct/indirect/induced economic impacts from businesses in the ocean sectors whose revenues depend to some extent on navigable waterways. If this calculation included the private boating-related economy, the ratio would be much larger.

Since most of the approximately 1,300 ocean-related businesses in the coastal counties of Massachusetts depend on the continued navigability of waterways, it is reasonable to consider in this analysis the economic contribution of these businesses, which includes 19,764 jobs, $1,589,568,277 in wages, and $3,208,348,162 in GDP (2012). Applying a multiplier to account for induced and indirect economic effects, the total economic contribution in 2012 for these businesses was $4,989,336,697 in wages and $12,041,535,375 in GDP.[6] While there is not a direct relationship between the investments in dredging and the economic activity of such businesses, these industries are dependent on navigable waterways maintained by dredging, without which these businesses would certainly suffer some loss in economic activity.

Failure to maintain authorized depths through maintenance dredging has a wide range of impacts on the functioning and safety of our harbors, as well as on local, State, and regional economies. If dredging is not completed as needed, the harbor may experience a loss of slips and/or moorings, a limit on vessel draft able to access the harbor, vessel operational constraints, and fewer local/transient vessels, all of which could result in economic losses along with public safety issues. If dredging is done as needed, these harbors could experience an increase in local/transient vessels, water-dependent activities, and boating activity as a whole, which would likely have positive impacts on the economy.

It would be advantageous for sound decision making to regularly (e.g., every five years) update this State of Our Harbors report. The methodology and products developed for this report were designed to facilitate future updates (in terms of effort and cost). Navigable waterways are a part of the Commonwealth's transportation infrastructure and as with all publicly-supported infrastructure, the return —measured in both economic and quality of life terms— far exceeds the cost to the State, municipalities, and all entities engaged in ocean- and coastal-dependent

[6] Employment multipliers range from 1.24 to 6.52 with an average of 3.29 and a median of 2.78. Employee Compensation multipliers range from 2.48 to 4.46 with an average of 3.0 and a median of 2.75. Value Added multipliers ranged from 2.75 to 5.96 with an average of 3.42 and a median of 3.21. See Appendix I for more details.

commercial and recreational activities in Massachusetts. An investment in dredging is an investment in the state's economy and should be a priority for Massachusetts.

The full report and supporting documentation provides more detail on each of these findings, as well as the study's methodology. The team designed the study methodology to enable regular updating of the data and findings in support of decision-making regarding investments in dredging and the water-dependent activities along the coastline.

In addition to this report, the project produced: 1) a database with information on prior dredge projects and future dredging needs; 2) summary pages on each harbor within Massachusetts, including dredging needs, boating facilities, and features unique to each harbor (Appendix A); 3) ArcGIS data layers of boating facilities and approximate dredged areas for the harbors along the coast of Massachusetts.

The databases and maps of dredged areas and shoreside facilities provide an accessible resource for harbormasters and others to record edits to mapped features, and to update data on dredging needs and dredging projects completed. If interested, please contact the Urban Harbors Institute at 617-287-5570 for more details on these products.

CHAPTER 1: INTRODUCTION

1.1. BACKGROUND

Along the coast of Massachusetts are 204 harbors located within 73 municipalities[7]. The size and scale of these harbors vary; some support large concentrations of shipping such as Boston and New Bedford, others are a mix of commercial and recreational boating and fishing, and some consist of small fleets of recreational boats. Regardless of size or function, these harbors have significant economic, cultural, and recreational importance to their communities and the region.

While the scale of activity and the specific uses of each harbor vary, many harbors share a common need for public dredging to maintain navigability. Dredging is "the removal or repositioning of sediment or other material from below the mean high tide line for coastal waters and below the high water mark for inland waters. Dredging shall not include activities in bordering or isolated vegetated wetlands."[8] Sedimentation occurs in Massachusetts harbors and in waterways throughout the world, creating shallow waters that require dredging in order to remove the deposited sediment.[9]

Dredging is needed for a variety of reasons, including to:

- Maintain waterways and channels for safe navigation,
- Meet current and future boating and boat storage needs within many harbors, and
- Improve environmental conditions, including water quality.

More specifically, dredging for purposes of improving and maintaining vessel access to the ports and harbors is vital to the national, regional, and local economies. Dredging of channels and basins enable the operation of large cargo and passenger ships to reach port facilities to load and offload; commercial fishing vessels to reach protected berths and facilities to land their fish; ferries to transport commuters and visitors; and a variety of recreational industries and activities, such as boating, fishing, whale watching, and charter boats.

In addition to influencing economies, dredging can also increase access for water activities. Many marinas, boatyards, yacht clubs, and municipalities dredge to maintain or increase water depths in mooring fields and at municipality piers, docks, and boat ramps. Nearly all mooring fields in Massachusetts coastal municipalities are at capacity, many with very long waiting lists. Shallow depths at a number of mooring fields and dock/slip spaces mean boats may ground during low tide, affecting when boaters can use their boats. Additionally, a number of boat launch ramps have operational limitations due to shallow water depths, further diminishing boater access to coastal waters.

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[7] This number, 204, reflects municipal jurisdictions within harbors, meaning that each town's portion of a shared harbor was counted as a separate harbor. Ignoring municipal jurisdictions, there are a total of 164 harbors.
[8] United States. Massachusetts Department of Environmental Protection. 401 Water Quality Certificate. N.p., 24 Oct. 2014. Web. 19 Jan. 2016. <http://www.mass.gov/eea/docs/dep/service/regulations/314cmr09.pdf>.
[9] National Oceanic and Atmospheric Administration (NOAA). *What is dredging?* NOAA, 29 January 2014. Web. 26 October 2015. http://oceanservice.noaa.gov/facts/dredging.html.

Dredging to maintain navigable depths concerns vessel safety as well: the United States Coast Guard ranked boat "groundings" as one of the top five primary recreational boating accident types in 2014[10].

Dredging is also conducted to improve environmental conditions in waterbodies where the exchange with open water is constricted. Increased flushing and improved circulation reduces exposure of local fish, wildlife, and people to contaminants in the waterways.[11] These contaminants are often the result of pollutants entering the waterways through sources such as sewer overflows, municipal and industrial discharges, surface runoff, or spills.[12] In some instances, dredging not only improves circulation and flushing, but also removes contaminated sediment. For example, New Bedford Harbor is currently contaminated with polychlorinated biphenyls (PCBs) and heavy metals which pose a significant risk to human health and the environment[13]. The U.S. Environmental Protection Agency (USEPA) and other agencies have been dredging since 2004 to remove contaminated sediment to improve environmental conditions in the harbor.

While dredging can improve environmental conditions in a waterbody, it can also have negative impacts on habitats and marine life in the vicinity of the dredge site. Environmental testing, time of year restrictions, and other considerations can help minimize negative impacts associated with dredging.

Dredging serves several critical functions; however, it is expensive. Funding for dredging of public projects in Massachusetts comes through a variety of sources, including but not limited to:

- Federal government
    - U.S. Army Corps of Engineers (USACE)
    - U.S. Environmental Protection Agency (USEPA)
- State government
    - Executive Office of Energy and Environmental Affairs (EEA)
    - Massachusetts Department of Conservation and Recreation (DCR)
    - Seaport Economic Council
    - Department of Environmental Protection (MassDEP)
    - Massachusetts Clean Energy Center (MassCEC)
    - Massachusetts Port Authority (Massport)
- Municipal governments

[10] U.S. Department of Homeland Security, U.S. Coast Guard, and Office of Auxiliary and Boating Safety. *2014 Recreational Boating Statistics.* May 8, 2015.
[11] National Oceanic and Atmospheric Administration (NOAA). *What is dredging?* NOAA, 29 January 2014. Web. 26 October 2015. http://oceanservice.noaa.gov/facts/dredging.html.
[12] Ibid.
[13] Environmental Protection Agency. *Harbor Cleanup.* 16 October 2015. Web. 26 October 2015. < http://www2.epa.gov/new-bedford-harbor/harbor-cleanup>.

While a variety of entities contribute to dredging activities within the State, the current public dredging needs surpass available funds. In recent years, the limited funds of the USACE have been directed to ports and harbors with the largest commercial maritime value.[14] Further, funding from other public sources remains scarce. Consequently, the need for dredging is a major concern among many Massachusetts harbormasters, municipal and state agencies, marine businesses, and the public that utilize these waterways for recreational and commercial activities.

1.2. STUDY PURPOSES, GOALS, AND OBJECTIVES

The Massachusetts Department of Conservation and Recreation (DCR) contracted Apex Companies, LLC from its Master Agreement List for Waterways Division Engineering Services to carry out tasks under Project Number P14-2882-D04 (3958-S). The Urban Harbors Institute, University of Massachusetts Boston, as subcontractor to Apex, led the development of the 2015 State of Our Harbors Report, the purpose of which was to assess the status of dredging within the coastal harbors of the Commonwealth of Massachusetts and estimate the costs and benefits of dredging to the Commonwealth and its coastal communities.

This report is an update to the 1990 study entitled "The State of Our Harbors: An Examination of Massachusetts Harbor Conditions and Related Economic Parameters" prepared by DCR. The 1990 study analyzed the status of dredging needs in Massachusetts at that time. Though guided by the objectives of the 1990 study, the scope of this study was not solely limited to updating the 1990 report's findings. Instead, in addition to updating the findings, this most recent effort created a process and products for documenting data in a format that will allow for additional analysis and future updates.

In keeping with the purpose of the project, the overall goal of the study was to develop a better understanding of the current state of Massachusetts' coastal harbors, public dredging needs, and the economic value of the activities that depend on navigable waterways. More specifically, this study had the following four objectives:

1. **Inventory the dredging history and current/future dredging needs in Massachusetts' coastal harbors.** The principal source of information pertaining to each harbor's dredging history and current and future dredging needs—including volumes, costs, entities involved, frequencies of dredging, and impacts of dredging/non-dredging—was the harbormaster of each municipality. The study also compiled and reviewed existing federal, state, and county (Barnstable) databases of past dredging to provide further information for projected frequencies and volumes of dredge projects.
2. **Determine the state and municipal revenue associated with dredged waterways, and the economic contributions of marine-related businesses in Massachusetts.** The study compiled and analyzed the revenue collected by the State through taxes related to boating activity, and information on boating and harbor-related fees and taxes collected by municipalities. Further, the study collected county-level data on Gross Domestic Product (GDP), employment, and wages from ocean-dependent business located in the coastal

[14] Lang, Jean. *Locals push for dredging of Duxbury Harbor.* 11 September 2014. Web. 26 October 2015. < https://www.bostonglobe.com/metro/regionals/south/2014/09/10/locals-push-for-dredging-duxbury-harbor-but-feds-rush/qDNRsNctBcvfnikuIo91EP/story.html>

counties to complete the economic picture. Consistent with the 1990 State of Our Harbors report, this study compared the annual boating-related revenue collected by the State and municipalities to the average annual investment in dredging in Massachusetts in the form of a ratio.

3. **Characterize the current conditions of each coastal harbor in Massachusetts.** This study gathered information on the cultural, commercial, and recreational importance of each harbor along the Massachusetts coastline. This included, specifically, information on the recreational boating facilities in each harbor, essential needs served by each harbor, and any current noteworthy issues.
4. **Create a baseline of dredging histories and needs that can be updated.** This study captured information about each harbor in a database. The expectation is that the information contained in the database and presented in this report will be updated regularly to serve as the basis for decision-making.

CHAPTER 2: GEOGRAPHIC SCOPE

The study focused on the public navigational dredging needs of the harbors along the Massachusetts coastline. Coastal harbors are the protected bodies of water—bays, estuaries, and rivers—where recreational and/or commercial vessels are docked or moored, often with associated landside access and facilities.

The 73 coastal municipalities and associated harbors included in this report are those with protected navigable waterways (dredged or not), and/or with recreational or commercial vessel operations. These harbors support nearly all of the berthing, waterfront facilities, and dredged areas used by such vessels. See Figure 1 for a map of the geographic scope of this study, and Appendix B for a list of the coastal municipalities and harbors.

As described in more detail in the inventory section, the procedure for identifying individual harbors was iterative, using a variety of sources and relying ultimately on confirmation of a definitive list by each municipality's harbormaster. While this project is an update of a similar report completed in 1990, and references are made back to that report, this study used a methodology designed specifically for this effort.

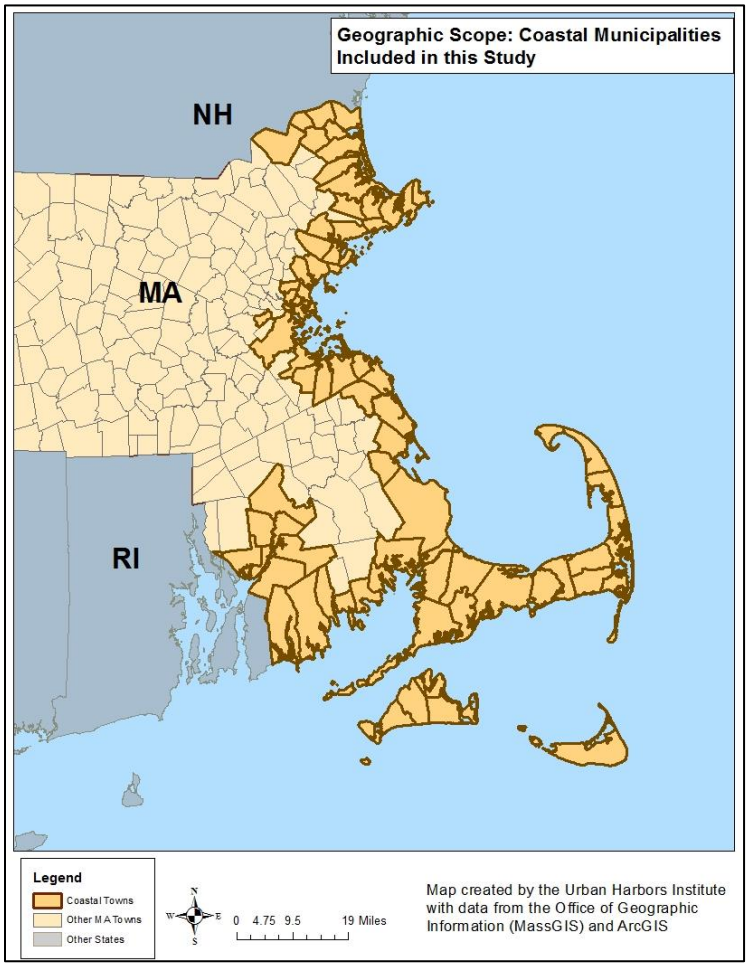

Figure 1. Geographic Scope: Coastal Municipalities Included in this Study.

CHAPTER 3: METHODOLOGY

The methodology for this study centered primarily on surveying harbormasters and researching existing databases/online resources to gather information on Massachusetts' harbors, dredging needs, and the impacts of dredging activities. UHI designed a 5-step methodology to complete this study, as shown in Table 1 and described below.

Table 1. Summary of study methodology.

Activity		Date
Step 1: Collect and compile available data from existing sources and through a preliminary survey of harbormasters		December 2014 - March 2015
Step 2: Develop and administer the State of Our Harbors Survey	Develop survey	February, 2015 – April 2015
	Administer paper survey	April 17, 2015
	Administer online survey	May 1, 2015
	Send first survey reminder	May 11, 2015
	Send second survey reminder	May 18, 2015
	Close online survey	June 30, 2015
	Follow up non-responses and confirm collected data	July 2015 - October 2015
Step 3: Calculate the economic benefits of dredging activities to MA		January 2015 - November 2015
Step 4: Calculate the projected and annual investments in dredging in MA		January 2015 - November 2015
Step 5: Data cleaning and analysis		August 2015 – November 2015

Step 1: Collect and compile available, reliable data and information on the Commonwealth's harbors from existing sources and through a preliminary survey.

UHI used the data collected through Step 1 to pre-populate the State of Our Harbors survey in Step 2. More specifically, UHI developed a list of coastal municipalities, harbors, marine boating facilities, and previous dredging activities/current dredging needs based on existing sources and a preliminary survey.

To develop an initial list of coastal municipalities and their respective harbor(s), UHI reviewed the following sources:

- The 1990 State of Our Harbors report;
- Dredging history from the USACE;
- Dredging history from the Barnstable County Dredge;

- Dredging history from DCR; and
- Google Earth (to complete visual scans to ensure potential harbors were not missed).

To develop the list of marine boating facilities, UHI used the following sources:

- Google Earth (state-wide search using the term "marina" and a visual scan for facilities);
- A GIS layer entitled "Sites of marinas, yacht clubs, and boat yards along the Massachusetts coast, 2007" (Source: MA CZM);
- A GIS layer of MA boat ramps entitled "Office of Fishing and Boating Access Sites" (updated August 2014) (Source: Office of Fishing and Boating Access); and
- Web search engines and USACE website to identify dredged areas within harbors.

UHI vetted these lists and additional information through a preliminary mail survey of harbormasters (see Appendix C). More specifically, through the preliminary survey, UHI confirmed and/or collected the following information:

- Harbormaster's name and contact information, and name(s) of any assistant harbormaster(s)
- Name of harbors located within the municipality
- Details about each harbor including:
  - Harbor boundary;
  - Locations and names of entrance, navigation, and main channels within harbor;
  - Harbor anchorages;
  - Mooring areas and boat basins (both dredged and natural) within each harbor;
  - Locations that have been dredged and/or need dredging;
  - Locations and names of marine-related shoreside facilities (e.g., boat yards, marinas, municipality docks, boat launches, ferry terminals, restaurants, condos or hotels/motels with slips).
- Preferred method of completing the State of Our Harbors Survey (paper or online)

Though harbormasters from only 39 out of 73 municipalities completed the preliminary survey (see Appendix D for a list of these municipalities), it generated a great deal of data and helped to identify 204 harbors (see Appendix B). The number of harbors varied by municipality, ranging from 1 harbor (e.g., Neponset River in Milton) to 16 harbors (e.g., Falmouth). For those 34 harbors without preliminary survey data, UHI relied on data from existing sources to pre-populate the survey.

Step 2: Develop and administer the State of Our Harbors Survey

Below are the details on A) Survey Development, B) Survey Administration, C) Survey Response Rates, and D) Filling Data Gaps.

A. Survey Development

UHI, in collaboration with the Center for Survey Research (CSR) at UMass Boston, designed the survey questions using the 1990 State of the Harbors report as a guide, along with input from DCR and the Massachusetts Office of Coastal Zone Management (CZM). In particular, UHI and CSR designed questions to update many of the prior conclusions from the 1990 report and to gather additional noteworthy information. Harbormasters reviewed and vetted the questions through a presentation to the North Shore Harbormasters Association and through individual conversations with other Massachusetts harbormasters.

Using the vetted questions, UHI and CSR developed both an online[15] and paper version of the survey (Appendix E), offering harbormasters the option of completing the survey through either means. UHI asked harbormasters to complete one survey for each harbor within their jurisdiction; therefore, in some cases, harbormasters completed multiple surveys.

The survey contained four sections:

1. Harbor Information – Collected general information on the harbor, including physical characteristics and number of slips/moorings.

2. Dredging - Collected information on prior public navigational dredging projects and current dredging needs, including volume, cost, responsible agencies, and timeframe. Identified dredge projects are often only discrete sections of a larger dredged area that has shoaled. This section also captured insights about the potential impacts of dredging versus not dredging, such as increases/decreases in numbers of slips and moorings.

3. Harbor Uses and Facilities - Collected information on boating facilities and mooring fields located within the harbor, including the number of slips, moorings, and boat ramps.

4. Municipal Revenue - Collected information on boating-related revenue for the municipality, including mooring permit/rental fees, boat excise taxes, and slip rental fees.

See Appendix E for the entire survey. As noted in Step 1 above, the UHI team pre-populated both the online and paper surveys with data gathered from the preliminary survey and existing resources/databases—specifically harbor names and features (e.g., the various mooring fields, channels, turning basins). See Appendix F for the Final Methodology Report completed by CSR at UMass Boston Survey Administration.

The team administered the survey during April and May, 2015 (see Table 1). UHI contacted many harbormasters throughout this period to encourage participation. For those harbormasters who did not complete the survey during the surveying period, UHI requested a phone or in-person interview to collect needed information (see Appendix D for survey response rates).

[15] The online version of the survey used Snap Survey Software (http://www.snapsurveys.com/)

C. Survey Response Rates

Of the 73 Massachusetts coastal municipalities identified for this study, 68 of the municipalities (accounting for 196 harbors) responded to the survey (see Appendix D). The majority of the 11 harbors in the other seven coastal municipalities are very small with minimal dredging needs, or surround in Boston Harbor, where existing data sources provided ample information.

D. Filling Data Gaps

To fill any data gaps, the team gathered information from facility and municipality websites, municipality harbor reports, general waterway guides, web search engines, dredge databases, and other reliable resources (e.g., newspaper articles). Additionally, UHI contacted the harbormasters in September 2015 to confirm/collect any missing data on dredging needs, estimated volume/cost, and municipal revenue.

Step 3: Calculate the economic benefits of dredging activities to Massachusetts

To expand on the survey data, UHI used existing databases to calculate the economic benefits of dredging activities to MA.

More specifically, UHI calculated:

A. Tax revenue (i.e., sales, fuel, boat excise, and income tax)

B. Employment, wages, and Gross Domestic Product

C. Fish landings

A. Tax Revenue

- Sales tax—State sales tax is calculated as 6.25% of the sale or rental price of tangible personal property. The U.S. Economic Census provides county-level information on the value of sales, shipments, receipts, revenue, or business, as classified by North American Industry Classification (NAICS) code. UHI identified appropriate NAICS codes using information from the National Oceanic and Atmospheric Administration's (NOAA) "Economics: National Ocean Watch" (ENOW) reports[16]. The calculated amount of sales tax for businesses in the ocean economy does not contain complete sales records for all counties due to privacy issues; therefore, this number likely underestimates the sales taxes collected by the ocean economy in Massachusetts in 2012. See Appendix G for ocean economy NAICS codes and counties included in the study.
- Fuel tax—Gas and diesel purchased in Massachusetts is taxed $0.24 per gallon, and the State uses that tax revenue to maintain roadways. Because boaters still have to pay a 6.25% tax at the pump even though they do not use roadways, they can receive a refund on gas tax from the State. This tax refund is rarely sought by recreational boaters, but is commonly sought by the commercial fishing community.

[16] These reports are based on data from the Bureau of Labor Statistics and the Bureau of Economic Analysis.

The Massachusetts Department of Revenue (DOR) gathers information on collected fuel tax, but does not keep records specifically on *marine* fuel purchases[17]. To estimate this piece of information, UHI gathered data on (1) recreational boater spending on fuel during the 2012 boating season[18], (2) "average" gas and diesel prices during the 2012 boating season[19], and (3) the percent of the boating population using gas compared to diesel, as reported in the 2012 Massachusetts boat registration databases. While these data have limitations (see Appendix H), they can provide an estimate of marine fuel spending by recreational boaters during the 2012 boating season. Because these data do not include spending by commercial boaters, UHI made the assumption that few, if any, boaters applied for the gas tax rebate. Even with that assumption, this is an underestimation of fuel tax revenue generated by the State because it does not include any commercial boating activity.

- Boat excise tax—Boaters must pay an annual boat excise tax for boats that are stored in Massachusetts. Collected boat excise taxes are split evenly between 1) the State and 2) the municipality where the boat is primarily stored.[20]

  The DOR does not keep records on the amount of boat excise tax collected by the State.[21] UHI estimated the 2014 boat excise taxes by applying the state's valuation calculation for boat excise tax[22] to vessel age/length, as reported in the 2014 state boat registration and federal documentation databases. This approach likely overestimates excise taxes, given that many municipalities collect only a portion of owed excise taxes each year.

- Income tax—The State taxes earned income, including salaries, wages, tips, and commissions, at 5.15%.[23] UHI combined this tax rate with the total calculated Employment Income to determine the estimated income tax collected by MA in 2012.

B. Employment, Wages, and Gross Domestic Product

The National Ocean Economics Program (NOEP) compiles economic data on business establishments, employment, annual wages, and gross domestic product for the Ocean Economy and Coastal Economy of the U.S. at the national, regional, state, and county level from 1990 to the present.[24] This project utilized 2012 data on the Massachusetts "Ocean Economy", comprised of

[17] Fox, J. September 2015. Personal communication with the Department of Revenue regarding the state's records on boat fuel tax.
[18] Starbuck K, Lipsky A. 2013. 2012 Northeast Recreational Boater Survey: A Socioeconomic and Spatial Characterization of Recreational Boating in Coastal and Ocean Waters of the Northeast United States.
[19] Stehle, T. October 2015. Personal Communication with the Senior Advisor and Skipper Bob Editor of Waterway Guide Media, which publishes monthly lists of gas and diesel prices for facilities in Massachusetts.
[20] The municipality is the place where the boat is moored/docked during the summer, or where the boat is registered/principally located during the calendar year if it is not moored/docked for the summer.
[21] Juszkiewicz, L. October 2014. Personal communication with the Director of the Division of Local Services at the state's Municipal Databank, regarding the state's records on boat excise tax.
[22] The valuation calculation is set forth in General Laws Chapter 60B §2(c). See Appendix K.
[23] Commonwealth of Massachusetts. 2015. Department of Revenue. Taxes & Rates. Personal Income. Online at: http://www.mass.gov/dor/all-taxes/income/.
[24] National Ocean Economics Program. 2015. Online at: http://www.oceaneconomics.org.

economic activity that directly or indirectly uses the ocean as an input, as opposed to the "Coastal Economy", comprised of all economic activity located in coastal areas regardless of whether that activity depends on the ocean. (See Appendix I for a list of NAICS codes included in the ocean economy and a table of calculations).

C. Fish Landings

The Massachusetts Division of Marine Fisheries (DMF) provided the live pounds (whole animal, with shell) and associated dollar value of all commercial fisheries landings for Massachusetts ports for both 2013 and 2014. The data include both wild harvest fisheries and aquaculture. The data provided by DMF originated from the Atlantic Coastal Cooperative Statistics Program (ACCSP), which collects and maintains fisheries data.

Step 4: Calculate the projected and annual investments in dredging in Massachusetts

In addition to calculating the economic benefits of dredging, UHI also calculated the A) annual investment in navigational dredging in MA, as well as B) projected funds needed for future projects.

A. Annual Investment in Dredging

Since the amount invested in dredging can vary dramatically year to year, UHI reviewed data from 2010-2014, to determine the average annual dredging investment over those years. Given that multiple entities provide dredging funds, UHI collected cost data from the following entities:

- Federal government
    - USACE
    - USEPA
- State government
    - EEA
    - DCR
    - Seaport Economic Council
    - MassDEP
    - MassCEC
- Municipal governments (Barnstable County Dredge and Municipalities outside of Barnstable County)

UHI totaled the cost data associated with projects funded during the years 2010 to 2014 to obtain the total cost of dredging for that time period. UHI then added 20% of those costs to the total cost in order to reflect expenses associated with permitting and testing. [25] That new total (the base costs + 20% of the base costs) was then divided by five years to obtain an average cost per year.

[25] The Department of Conservation and Recreation noted that the permitting and testing cost for dredge projects is typically approximately 20% of the total cost of the project.

B. Projected Funds Needed for Future Dredge Projects

In completing the survey, harbormasters listed the needed public navigational dredge projects per harbor, including volume and cost information.

Using that list, UHI calculated the projected funds needed to complete dredging projects in the next ten years, using the following guidelines:

- If the harbormaster provided the cost of the dredging need, UHI used that amount.
- If the harbormaster *only* provided an estimated volume for removal, UHI multiplied the following "cost per cubic yard" estimates by the volume to determine cost.

  For projects on Cape Cod and the Islands (we assumed use of Barnstable County dredge)[26]:

  - $7.80/cubic yard for pre-2014 projects; $9/cubic yard for 2014 projects
  - $11.40/cubic yard (with booster pump) for pre-2014 projects; $13/cubic yard for 2014 projects[27]

  For projects outside of Cape Cod and the Islands using regular hydraulic dredge (we only used estimates if harbormaster specified hydraulic dredge):

  - $25/cubic yard for a small project (less than 50,000 cubic yards)
  - $22/cubic yard for a large project (more than 50,000 cubic yards)[28]

  For projects outside of Cape Cod and the Islands (we assumed mechanical dredge if hydraulic dredge was not specified):

  - $50/cubic yard (can be up to $95/yard) for a small project
  - $100/cubic yard for a medium project (up to 75,000 cubic yards)
  - $85/cubic yard for a large project (more than 75,000 cubic yards)[29]
- For projects with no cost/volume, UHI used data on prior similar projects from existing dredging databases (e.g., USACE, Barnstable County Dredge).
- For projects with no cost/volume available from prior similar projects, UHI did not include the project in the calculation as the authors were not able to make estimates.

[26] Based on prices provided by the Barnstable County Dredge. The Barnstable County Dredge uses the hydraulic method. Note that the USACE also dredges on the Cape and Islands and does not always use hydraulic dredges.
[27] Cost per cubic yard estimates provided by the Barnstable County Dredge. Cost per cubic yard amounts increased in 2014 to $9/cubic yard and $13/cubic yard (booster projects).
[28] Cost per cubic yard estimates provided by DCR.
[29] Note, this number fluctuates, as mechanical dredging of the 117,000 cubic yards of material removed during the New Bedford harbor Interim Federal Channel Dredging project, conducted on behalf of EEA/CZM, was done at the rate of $34 to $47 per cubic yard. These rates reflect disposal into nearby Confined Aquatic Disposal (CAD) cells requiring short disposal trips, but do not include the cost of CAD cell construction.

Again, UHI then added 20% of those costs to the total cost in order to reflect expenses associated with permitting and testing. [30] The total cost of needed dredging over the next ten years reflects the sum of each needed project's cost. It should be noted that, historically, some projects have a federal, state, or local cost-share. Additionally, fuel prices can affect the cost per cubic yard of dredging. This calculation is based on current dredging prices noted above.

Step 5: Data Cleaning and Analysis

Cleaning the data provided by the harbormasters involved correcting any typos, removing number ranges, and ensuring data were comprehensible to an outside party. Data standardization guidelines can be found in Appendix J. UHI utilized the analysis tools in Microsoft Excel to develop the results presented in Chapter 4.

[30] The Department of Conservation and Recreation noted that the permitting and testing cost for dredge projects is typically approximately 20% of the total cost of the project.

CHAPTER 4: RESULTS

The results of this study are divided into the following sections:

4.1. Public Dredging Needs

4.2. Potential Impacts of Dredging Activities

4.3. Economic Considerations Related to Dredging

4.1. PUBLIC DREDGING NEEDS

Within the State's 204 coastal harbors, harbormasters identified 236 needed public dredge projects.[31] Survey responses, along with information from other existing dredging resources, indicate that at least 115 channels and 32 mooring areas need to be dredged, along with numerous areas around boat ramps, municipality piers, turning basins, and general shoals or "speed bumps" within harbors. The number of needed projects varied, with some harbors having no current public dredging needs and others having as many as nine locations in need of dredging. Note that the dredging needs and associated community impacts identified in this report are based on the results of a survey of harbormasters and, as such, are primarily the professional opinions of the harbormasters. Additionally, the dredge projects identified by harbormasters are public projects, and do not include private projects such as those conducted by private yacht clubs and marinas.

The size of dredging projects also varied. Harbormasters identified a variety of dredging needs, ranging from very large projects performed in entire harbors and channels (e.g., a current project to dredge New Bedford Federal Channel at a volume of 750,000 cubic yards[32]), to smaller projects involving the dredging of isolated shallow areas (e.g., Menemsha Basin in Chilmark at a volume of 150 cubic yards).

As the number and size of dredging projects varied, so did the timing of needed dredge projects. Out of the 204 coastal harbors within Massachusetts, 115 harbors (56%) need dredging within the next five years to ensure safe navigation of channels and mooring/anchorage of boats. At the project-level, harbormasters reported 65% of the dredge projects are immediate needs, 25% are needed within 5 years, and 9% are needed in more than 5 years (Figure 2).

[31] Some Massachusetts harbormasters also provided information on private dredging projects (e.g., dredging needed by marinas and yacht clubs). The private projects are not included in the 236 public areas in need of dredging, but they are included in the ArcGIS layer of approximate dredged areas and the harbor summary pages in Appendix A.

[32] Note: EEA/CZM just completed the New Bedford Interim Federal Channel Dredging Project, removing 117,000 cubic yards of material from the federal navigation channel inside and outside of the New Bedford Hurricane Barrier.

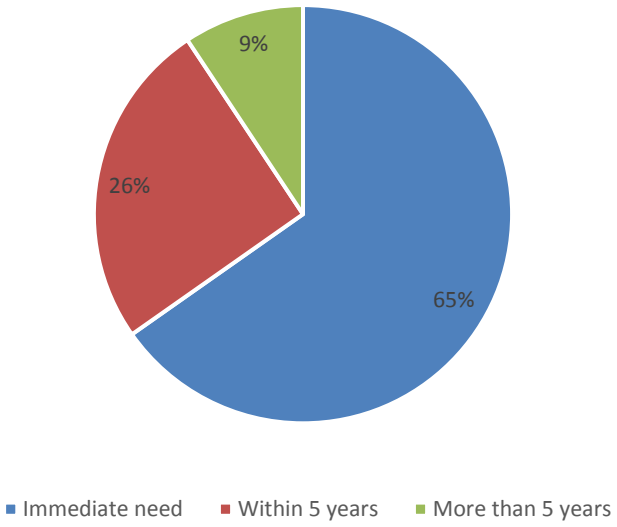

Figure 2. Timeframe for needed public dredge projects. (n = 236)

Most (70%) prior public dredge projects within Massachusetts were last dredged more than 10 years ago, 7% 6-10 years ago, and 12% were last dredged 3-5 years ago (Figure 3).

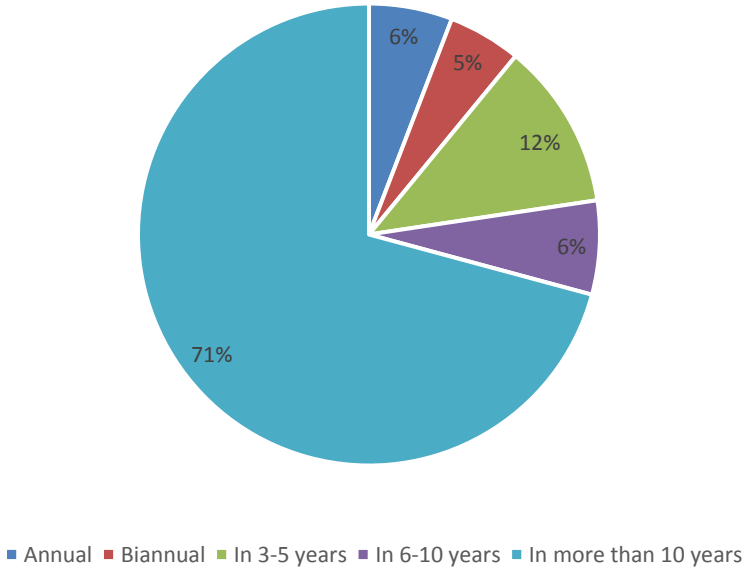

Figure 3. Frequency of dredging for most recent public dredge projects in each harbor reported by harbormasters. (n = 137)

Out of 151 identified past dredge projects within Massachusetts, the federal government was the lead party responsible for 33%, municipalities for 24%, counties for 23%, and the State for 13% (Figure 4). Note that these estimates are only for 151 prior dredge projects identified by harbormasters, and do not represent ALL completed dredge projects within Massachusetts.

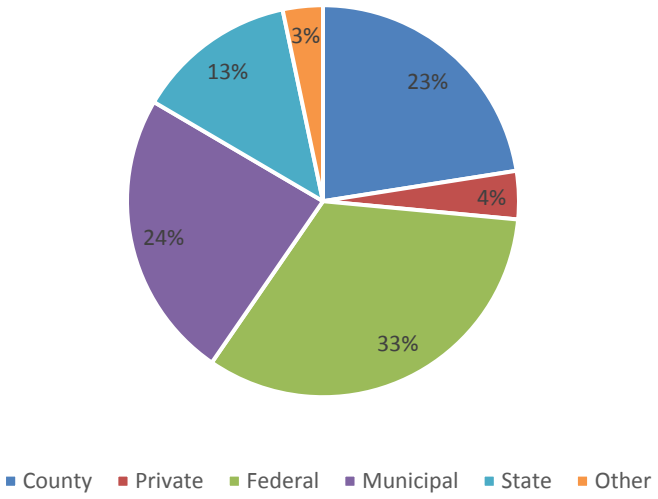

Figure 4. Lead party responsible for most recent public dredge projects in each harbor reported by harbormasters. (n = 151)

The estimated cost of the 236 needed public dredging projects over the next ten years is well over $288 million. Cost could not be attributed to approximately one-third of the needed dredging projects, as neither the volume of material that needs to be removed nor the cost could be estimated.

4.2. POTENTIAL IMPACTS OF DREDGING ACTIVITIES

Harbormasters provided extensive information on the impacts if a needed dredge project is 1) NOT done, or 2) IS done. Results are below. Note that these results are based on harbormasters' quantitative and qualitative responses, which were mixed in terms of detail and level of completion; therefore, the responses do not capture all impacts, nor are the impacts applicable to all dredging projects.

A. Dredging Impacts – If a Dredge Project is NOT Done

If a dredge project is not done, almost half of the uncompleted projects (43 out of 88 (49%)) would result in a loss of slip usage (Figure 5), and 63 out of 98 (64%) would result in a loss of mooring usage (Figure 6). Additionally, if the dredge project is not done, 83 out of 88 (94%) would experience vessel draft limitations (Figure 8). Some harbormasters specifically noted that, without a specific dredge project, "deeper draft boats can't use" the area, "boats have relocated", and "people [navigate] around the tides."

Some harbormasters noted that slips and moorings would still be useable, but the operation of boat would be tidally dependent (e.g., boats could only enter and leave at the higher end of the tidal cycle). Additionally, harbormasters noted that moored/docked boats are often grounded during a low tide, emphasizing the influence that the tides currently have on boating activity.

The impacts noted above also have economic ramifications. More specifically, 71 out of 93 (76%) of the projects would result in a loss of direct revenue to municipalities, the State, businesses, and

others if the dredging is not done (Figure 9), with revenue loss ranging from $825 to $5,000,000. These estimates do not include direct revenue lost to Boston and New Bedford, where amounts would be considerably larger.

Additionally, 81 out of 94 (86%) of the needed dredge projects reported by harbormasters will have "other impacts" if the dredging is not done (Figure 7). More specifically, "other impacts" reported include:

- Inability to navigate in an emergency (public safety)
- Lack of storage for boats
- Lack of use of area/No access to area
- Boat groundings in shallow water
- Travel limited by tidal state
- Rough water due to shallow areas of sand
- Water quality issues/Need more flushing/Shellfish bed destruction
- Fewer local and transient vessels
- Homeowners and shore-side businesses negatively impacted
- Commercial/recreational fishing fleet impacted
- Loss of yacht club membership and participation

Dredging Impacts – Dredge Project is NOT Done

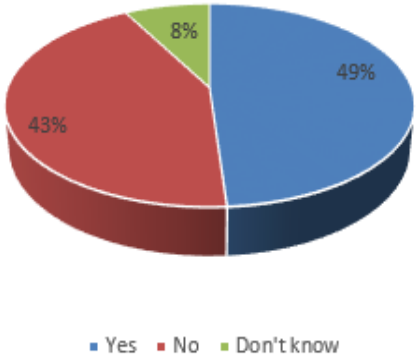

Figure 5. Loss of slip usage. (n = 88=)

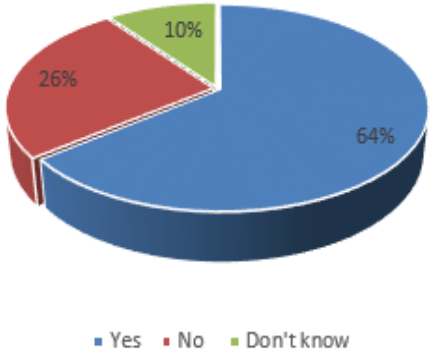

Figure 6. Loss of mooring usage. (n = 98)

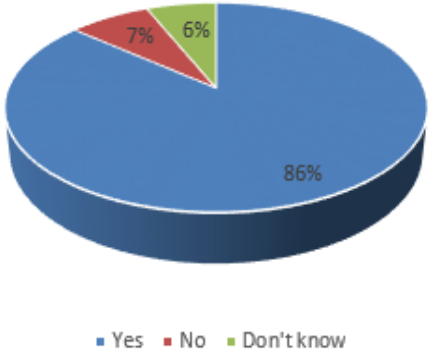

Figure 7. Other impacts. (n = 96)

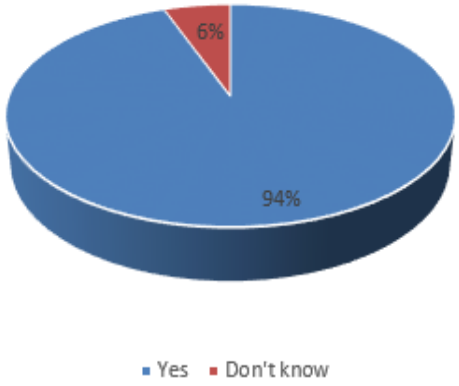

Figure 8: Limit of vessel draft size. (n = 88)

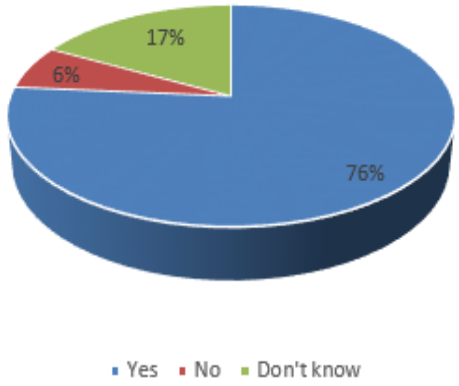

Figure 9: Loss of direct revenue. (n = 93)

B. Dredging Impacts – If a Dredge Project IS Done

If completed, 56 out of 85 (66%) of the needed projects will result in an increase in commercial and/or recreational vessel-related activity (Figure 10). This additional activity will stem from both more boat use by local boaters and an increase in transient vessels. To that point, if completed, harbormasters noted that 42 out of 47 (89%) of the needed projects will result in an increase in vessels (Figure 11), and 33/41 (80%) in an increase in transient boaters (Figure 12). Some quantified the additional number of vessels, while others provided more qualitative data, including:

- Improved safety in mooring areas and at slips
- Better overall access, and additional moorings and slips available
- Harbor use at all tides, and more boat usage consistently throughout the day
- The addition of a transient docking facility or moorings/slips in areas currently filled with sand
- Accommodation of deeper draft vessels

In some cases, if a dredge project is completed, the *amount* of boating activity may not necessarily change, but rather the *time of day* when boats could utilize that area would NOT be on a tidal schedule.

Additionally, if completed, 29 out of 45 (64%) of the needed dredge projects would result in more water-dependent activities (Figure 13), including:

- Small boat use
- Swimming
- Aquaculture (due to improved water circulation)
- Shellfishing
- Launch service
- General water sports

Finally, if completed, most (39 out of 43 (91%)) dredge projects would create economic benefits (Figure 14), including:

- A more efficient commercial fishing fleet
- Increased vessel traffic, which results in more revenue generated by boat yards, marinas, downtown businesses, the fuel dock, etc.
- Increased consumption and sales of a local food source (e.g., shellfish)
- Additional jobs related to enhanced boating activity
- Increased revenue, including mooring fees and boat excise taxes
- Increased visits from transient vessels
- Larger vessels able to access the harbor, resulting in greater revenue

As one example of how a dredging project can lead to economic benefits, FXM Associates noted that dredging the Federal Channel in New Bedford Harbor will result in an additional $168 million in economic output and 1,200 jobs.[33]

Chapter 5 (discussion) provides additional benefits of dredging that were not mentioned in the survey responses, such as the beneficial reuse of dredge material for purposes such as beach nourishment.

[33] FXM Associates. *Port of New Bedford, Benefit/Cost Analysis of Navigational Dredging.* New Bedford Harbor Development Commission and the U.S. Army Corps of Engineers.

Dredge Impacts – Dredge Project IS Done

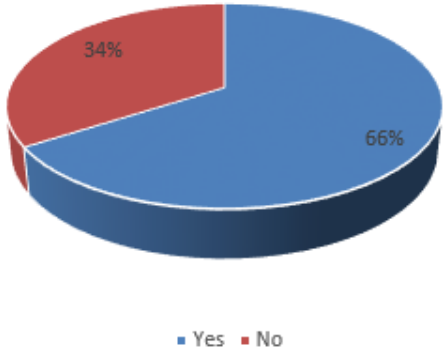

Figure 10. More commercial and/or recreational vessel activity. (n = 85)

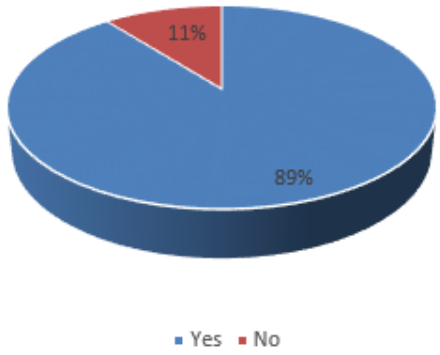

Figure 11. More local vessels. (n = 47)

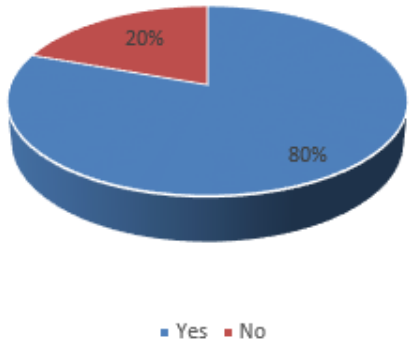

Figure 12. More transient vessels. (n = 41)

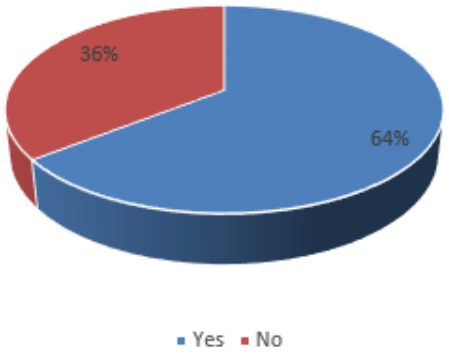

Figure 13. More water-dependent activities. (n = 45)

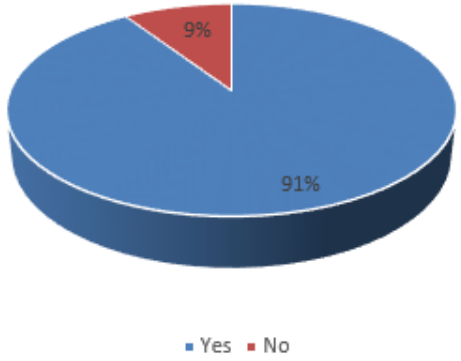

Figure 14. More economic benefits. (n = 43)

4.3. ECONOMIC CONSIDERATIONS RELATED TO DREDGING

As noted previously, dredging activities can have a considerable effect on state and municipal economies. The economic results below contain data from the survey and current databases, and are divided into the following sections:

A. Economic Benefits of Dredging

B. Average Annual Investment in Navigational Dredging Activities in Massachusetts

C. Dredging Revenue to Investment Ratio

A. Economic Benefits of Dredging

Dredging can result in a multitude of economic benefits, as explained below.

(1) Employment, Wages, and Gross Domestic Product

The State and municipalities benefit economically from dredging activities in many ways. In Massachusetts, navigable waterways supported the existence of 1,311 ocean-related businesses in 2012. These businesses supplied an estimated 19,764 jobs, whose employees earned $1,589,568,277 in wages. This economic activity created a direct economic contribution of $3,208,348,162 in Gross Domestic Product.

In addition to direct economic benefits, economists also estimate indirect and induced benefits to more fully capture the fiscal impacts of dredging. More specifically, the Impact Analysis for Planning (IMPLAN) model's economic multipliers estimate total economic contribution, including "secondary effects of supply chain activity or input purchases (indirect effects) and re-spending of income by employees, business owners and governments (induced effects) arising from new final demand."[34]

Using the IMPLAN multipliers to capture these indirect and induced effects shows that, in 2012, the total economic contributions of the Massachusetts ocean economy impacted by dredging were 71,184 jobs; $4,989,336,697 in wages; and $12,041,535,375 in GDP.[35]

(2) Taxes and Fees Collected by the State and Municipalities

Another way to look at the economic significance of dredging is to understand the tax and fee-related revenue generated by harbor-related activities, including marine fuel tax, income tax for ocean economy-related employees, sales tax, boat excise tax, and municipality-collected fees. Results are described below and in Table 2.

1. Marine Fuel Tax – In 2012, recreational boaters spent an estimated $52,715,413.36 on fuel (both gas and diesel) during the boating season[36]. Using the 2012 tax rate of $0.21/gallon,

[34] Hodges, A.W., Stevens, T.J., Rahmani, M., and R. Swett. 2013. Economic Analysis of Working Waterfronts in the United States. Online at: http://www.wateraccessus.com/econ/economicsfinalreport.pdf

[35] Employment multipliers range from 1.24 to 6.52 with a median of 2.78. Employee Compensation multipliers range from 2.48 to 4.46 with a median of 2.75. Value Added multipliers ranged from 2.75 to 5.96 with a median of 3.21. See Appendix I for more details.

[36] Starbuck K, Lipsky A. SeaPlan. 2012 Northeast Recreational Boater Survey: A Socioeconomic and Spatial Characterization of Recreational Boating in Coastal and Ocean Waters of the Northeast United States. Technical

the State collected approximately $2,552,214.51 in marine fuel taxes from recreational boaters in 2012 (see Appendix H for a detailed methodology of this calculation). Some boaters request a tax rebate[37] from the State; however, anecdotal reports suggest that very few recreational boaters actually request the rebate. Even with the rebate, the calculated $2.5 million does not include fuel sales to commercial vessels, inferring that this number is an underestimation.

2. Income Tax for Those Working in the Ocean Economy – UHI applied the 2012 Massachusetts income tax rate of 5.25% to the annual average wages data for a total of $83,452,334.54 in income tax paid to the State from employees in ocean-based industries in 2012.
3. Sales Tax - The sale and rental of tangible property within the Massachusetts Ocean Economy in 2012 resulted in a total state sales tax of approximately $135,734,326.67. This number does not include several sectors of the Ocean Economy for which data are not available; however it also likely over-estimates sales taxes directly attributable to dredging activity.
4. Boat Excise Tax— The maximum amount Massachusetts received in boat excise taxes in 2014 was approximately $1,865,817 (See Appendix K for methodology). While municipalities collect excise taxes and share them equally with the State, many municipalities are unable to collect ALL excise taxes; therefore, the true amount of boat excise taxes is likely lower than the estimated amount.

   In addition to these calculations, harbormasters and the towns' Assessors Offices provided boat excise tax information for almost every municipality. Appendix A contains information about the amount each municipality collected in excise taxes in 2014, if the information was available.
5. Municipality-Collected Fees – Municipalities collect fees from boaters, including but not limited to mooring permit and rental fees, slip rental fees, and launch fees, which totaled to approximately $14,028,166 in 2014. Since UHI was unable to collect fees for every municipality, this number is an underestimation.

Report Dec 2013. Online at: http://www.seaplan.org/wp-content/uploads/2012-NE-Survey-tech-report121.13.101.pdf.

[37] The rebate is for the entire tax, less a 6.25% use tax charged on the value of the purchase

Table 2. Revenue generated by the state and municipalities from taxes and fees.

State Benefits (2012, unless otherwise noted)	
Income taxes	$83,452,334
Fuel taxes	$2,552,214
Sales taxes	$135,734,326
Excise taxes (2014)	$1,865,817
State Benefits Total	**$223,604,691**
Municipal Benefits (2014)	
Excise tax	$1,865,817
Mooring permit fees	$4,800,752
Mooring rental fees	$1,043,802
Slip rental fees	$6,085,174
Ramp launch fees	$68,860
Other	$163,761
Municipal Total	**$14,028,166**
TOTAL	**$237,632,857**

(3) Fishing-Related Revenue

Another metric of the significance of the ocean economy is the revenue generated by fishing activity in the State. Data provided by the DMF show that fishermen landed more than 3.5 billion pounds of fish and shellfish in Massachusetts in 2013, and nearly 3 billion pounds in 2014. The values of these landings were $4,133,222,453 and $3,474,582,121 in 2013 and 2014 respectively (Appendix L).

B. Average Annual Investment in Navigational Dredging Activities in Massachusetts

This study estimates the total spending on public navigational dredging in Massachusetts between 2010 and 2014 at approximately $36,758,513, with the average annual investment in dredging at $7,351,703. It is worth noting that the cost of dredging is closely tied to fuel prices, and future annual expenditures will reflect changes in fuel prices. Data also indicate that the USACE funded roughly two-thirds of the dredging projects completed between 2010 and 2014, not including funding already committed to the dredging of Boston Harbor in 2017.

Table 3 shows estimates of the public navigational dredging investments made by each entity between 2010 and 2014 for Massachusetts coastal harbors, including the estimated average annual investment to dredge Massachusetts coastal harbors. Consistent with the goals of this study, these investments do not include projects conducted for purposes other than navigation (e.g., environmental remediation). Furthermore, the investments do not reflect projects slated for 2015 due to incomplete data for this current year of dredging activity.

More specifically, investments do not include:

- Large port improvement projects (e.g., dredging projects to create new navigable areas) that are considered "anomaly projects" due to their extremely high cost, such as the construction of the Marine Commerce Terminal in New Bedford (approximate cost: $133,000,000).
- Remediation/clean-up dredging, which includes approximately $345 million spent by USEPA, MassDEP, and others to remove contaminants from New Bedford Harbor.
- 2015 dredge projects, which include approximately $900,000 invested by EEA to dredge New Bedford Harbor.
- Post-2015 dredge projects, which include the future dredging of Boston Harbor with investments from the USACE at approximately $310 million, and investments by Massport at approximately $60 million.
- Private investments, including investments made in dredging by private marinas, yacht clubs, and other entities.

Table 3. Public navigational dredging investments in Massachusetts coastal harbors from 2010 to 2014[38].

Organization	Investment in Public Navigational Dredging						Notes
	2010	2011	2012	2013	2014	TOTAL	
USACE	$4,622,090	$5,425,336	$6,759,430	$1,035,048	$2,434,161	$20,276,065	--
Massachusetts Coastal Municipalities Outside Barnstable	$160,000	$0	$0	$900,000	$0	$1,060,000	--
Seaport Economic Council	$275,000	$0	$0	$50,000	$0	$325,000	--
State Agencies							--
a. DCR	$2,309,576	$70,000	$1,475,000	$200,000	$100,000	$4,154,576	--
Barnstable County Dredge	$1,209,163	$979,552	$962,579	$613,135	$1,052,024	$4,816,453	--
TOTAL INVESTMENT	**$8,575,829**	**$6,474,888**	**$9,197,009**	**$2,798,183**	**$3,586,185**	**$30,632,094**	--
TOTAL INVESTMENT * 20%						$6,126,419	*20% (accounts for permitting and testing)
TOTAL INVESTMENT + 20%						**$36,758,513**	Dredging cost plus 20% fees
ESTIMATED AVERAGE ANNUAL DREDGING INVESTMENT						**$7,351,703**	Total divided by 5 years

C. Dredging Revenue to Investment Ratio

As noted previously, the estimate of the boating-related annual revenue generated by the State/municipalities through taxes and fees is approximately $237,632,857, and the average annual

[38] Note: As most of this analysis occurred during 2015, we did not include dredging investments from that year, including the EEA/CZM expenditure for dredging the federal channel at New Bedford, which came to a total of $6,361,156.

dredging investment on public projects in Massachusetts is approximately $7,351,703. Calculations for the ratio of revenue to investment are below.

> Revenue/Investment = Tax and fee revenues generated by the State and municipalities, divided by investment:
>
> $237,632,857/$7,351,703 = $32

As such, the estimated ratio of this tax and fee revenue to investment is approximately 32:1. **NOTE**: This estimate *only* includes revenue generated by the State/municipalities through taxes and fees, and does not include the multitude of economic impacts of dredging activity, including the benefits of indirect/induced effects, as well as the revenue generated by businesses, water-dependent activities, or other entities as a result of dredging, or the money saved on fuel and labor costs associated with having to wait on tides and chose longer routes due to navigational hazards. If this calculation included the private boating-related economy, the ratio would be much larger.

CHAPTER 5: DISCUSSION

Chapter 5 presents a discussion of the current dredging needs; the financing of dredging projects; and impacts of dredging projects within Massachusetts.

5.1. DREDGING NEEDS

Harbors on Cape Cod and the Islands, in particular, have very dynamic sediment transport processes, resulting in sediment build-up and navigational issues.[39] Additionally, Cape Cod is exposed to frequent storms and intense wave energy, enhancing the need for frequent maintenance dredging.[40] Coastal harbors outside of Cape Cod, including the North Shore, Boston area, South Shore, and South Coast, also experience a great deal of sediment build-up and require frequent dredging, especially in the mouths of rivers, throughout navigation channels, and in mooring fields/anchorage areas.

Sedimentation and other physical impediments can reduce the navigability and safety of waterways and cause costly delays to commercial users whose schedules are limited by the tides; reduce the size and number of vessels that can dock/moor in a harbor; and impair the ability of harbormasters and first responders to safely respond to a maritime emergency. These impacts have consequences for economies and cultures throughout the Commonwealth.

In fact, according to survey responses, more than half of the 204 coastal harbors (56%) within Massachusetts—representing a total of 236 projects—need public dredging within the next five years to ensure safe navigation of channels and mooring/anchoring of boats. This number is consistent with an estimate provided by a spokesman for the USACE New England District, who stated that "at any given time, half of the harbors [in New England] may be in need of dredging."[41]

5.2. FINANCING PUBLIC DREDGING PROJECTS

Though dredging is needed in 56% of the harbors identified in this study, securing adequate funding is the impediment to completion of most of these projects.

In Massachusetts, the federal and state governments, municipalities, and others are investing, on average, a combined total of approximately $7.4 million[42] on public navigational dredge projects each year. The USACE contributed an annual average investment of $4,055,213 to dredge Massachusetts coastal harbors between 2010 and 2014, and the State and municipalities each contributed approximately $1 million per year. Again, these investment averages do not include the

[39] Henson, Truman, Jr. Small Harbor Dredge Management – A Regional Approach to on Cape Cod, Massachusetts. Proceedings of the 12th Biennial Coastal Zone Conference. 2001. Online at: http://webapp1.dlib.indiana.edu/virtual_disk_library/index.cgi/4916229/FID3790/pdf_files/hensont.pdf

[40] Ibid.

[41] Lang, Jean. "Locals push for dredging of Duxbury Harbor." Boston Globe. September 2014. Online at: https://www.bostonglobe.com/metro/regionals/south/2014/09/10/locals-push-for-dredging-duxbury-harbor-but-feds-rush/qDNRsNctBcvfnikuIo91EP/story.html

[42] This estimate does not include projects to clean-up the environmental conditions of harbors, including the estimated $400 million effort to clean-up New Bedford Harbor, and other port improvement projects.

$400 million effort funded by state agencies and others to clean-up New Bedford Harbor, the pending improvement dredging for Boston Harbor, nor investments in private dredging.

This current rate of funding represents only 26 percent of the money required to complete the projects identified as needing to be performed in the next ten years, given that the estimated cost of public navigational dredging projects over the next ten years is *at least* $288 million—and likely much more. This is an underestimation due to the fact that cost estimates for approximately one-third of the projects were either unknown or not available, and could not be estimated given the wide variability in the cost of dredging projects.[43] If information was available for the projects whose costs are not known, that percentage would be even lower. Additionally, this does not include the costs of needed dredging of private facilities such as marinas and yacht clubs, nor the economic benefits (cost savings) to private marine facilities when they are able to "piggy-back" on a public navigational dredging project.

Competition for these limited funds is high. In general, the USACE only receives funding to dredge approximately 3-4 harbors within New England each year. Additionally, a number of needed dredge projects in Massachusetts are in harbors that support recreational boating activities, which are not competitive for USACE funding against larger commercial ports nationwide. Despite the high competition, harbormasters indicated that the USACE has been the lead responsible agency on the largest share of the 151 identified dredge projects (33%). It should be noted that this result is based on *only* the 151 identified projects reported by the harbormasters, and there is a large number of additional projects within federal, state, and municipal dredge databases.

Furthermore, while President Obama's budget and Congress provided more federal funds than expected for dredging this current fiscal year, in general, federal funds and appropriations for dredging are on a downward trend. Because of this, additional funds are needed by the State, municipalities, and other entities to maintain and potentially enhance navigable waters within Massachusetts. These additional funds will help ensure the timely dredging of harbors. Staying current on dredge projects keeps down costs and minimizes disruption to the municipal, state, and federal economies.

5.3. IMPACTS OF DREDGING PROJECTS IN MASSACHUSETTS' COASTAL HARBORS

Dredging is critical to state and municipal economies, promotes safety on the water, and ensures access to marine and coastal resources. These impacts of dredging are described further below.

A. Economic Impacts

The investment in dredging can result in a variety of economic benefits for marine-dependent businesses, municipalities, the State, and others. A number of ocean-related businesses are dependent on navigable waters, meaning that a large portion of their income is directly dependent on dredging.

[43] Fuel prices can affect the cost per cubic yard of dredging. This estimate is based on current dredging prices provided by either harbormasters or state agencies.

In 2012, the direct economic contribution of the 1,311 ocean-related businesses in Massachusetts was $1,589,568,277 in wages and $3,208,348,162 in GDP. After utilizing a multiplier to account for induced and indirect economic effects, the total economic contribution for these businesses was $4,989,336,697 in wages and $12,041,535,375 in GDP.[44] While there is not a direct relationship between the investments in dredging and the economic activity of such businesses, these industries are dependent on navigable waterways maintained by dredging, without which these businesses would certainly suffer some loss in economic activity.

Additionally, the State and municipalities collect revenues, fees, and taxes from boaters. Again, there is not a direct relationship between dredging and revenue/tax amounts, but navigable waters are essential for an active boating community and for the future generation of revenue/taxes.

In addition to jobs, wages, GDP, and harbor-related taxes and revenue, another way to think about the economic impacts of dredging is to look at the relationship between the cost of dredging and the revenue generated by dredging. The estimate of the boating-related annual revenue generated by the State/municipalities through taxes and fees is approximately $237,632,857, and the average annual dredging investment in Massachusetts is approximately $7,351,703. The estimated ratio of this dredging revenue to investment is approximately 32:1. **NOTE**: This estimate *only* includes direct revenue generated by the state and municipalities through taxes and fees related to the use of coastal waterways. It does not include the direct/indirect/induced economic impacts from businesses in the ocean sectors whose revenues depend to some extent on navigable waterways. If this calculation included the private boating-related economy, the ratio would be much larger.

If dredging projects are not completed, the degree of potential losses varies greatly from harbor to harbor. Losses might range from a loss of customers or income by water-dependent businesses and industries (and even for less boating-dependent businesses such as restaurants and hotels) to the loss of facilities such as yacht clubs, marinas, recreational tours, ferry services.

If dredging projects are completed, benefits might include increased numbers of boaters coming to, and spending money in a harbor, and an increase in harbor-related employment. The scale of economic benefits of a dredge project varies from harbor to harbor. For example, a dredging project in Boston Harbor, which supports recreational boating, commercial fishing, cruise and ferry operations, and port operations, would have considerably larger economic impacts than a dredging project in a much smaller harbor that supports a small recreational boating community. Comparing dredge projects based solely on the economic scale of the impacts of dredging, however, runs the risk of undervaluing a smaller project that has significant importance such as keeping open a channel for a municipality's fishing fleet.

Additionally, a number of commercial fishing fleets rely on navigable waters to conduct their business. More specifically, large commercial fleets operate out of ports such as New Bedford, Gloucester, and Chatham (Aunt Lydia's Cove), and the inability to navigate shallow water could result in a considerable loss of revenue.

[44] Employment multipliers used range from 1.24 to 6.52 with an average of 3.29 and a median of 2.78. Employee Compensation multipliers used range from 2.48 to 4.46 with an average of 3.0 and a median of 2.75. Value Added multipliers used ranged from 2.75 to 5.96 with an average of 3.42 and a median of 3.21. See Appendix I for more details.

Dredge material can also be a valuable resource and the reuse of material from completed dredge projects has multiple potential benefits. For example, where circumstances allow, the reuse of dredge material for beach nourishment is a cost-effective alternative to ocean or upland disposal, reducing handling and transportation costs. It is, in fact, the preferred disposal alternative of coastal resources managers when the sediment is suitable and there is a nearby beach that would benefit from additional material. Renourishing a beach with dredge material mitigates coastal erosion and provides shore protection, resulting in economic benefits of reduced storm damage to coastal properties and coastal infrastructure, as well as the possibility of generating additional recreational revenue from beach goers.

There are also environmental benefits of renourishing beaches with dredged material. Doing so can create or protect beach or marsh habitat for threatened or endangered plants and for sea turtles, shorebirds, and other beach dwellers. The economic value of these environmental benefits is significant, but difficult to quantify, and was not part of this project.

B. Boating Activity and Access

The 1990 State of Our Harbors study reported that boat owners registered 224,115 boats[45] in Massachusetts in 1990, which is considerably larger than the number of boats registered and documented in 2014 (145,563). While there is a general decrease in the number of registered boats between 1990 and 2014, there has been a slight increase in registered boats (approximately 6,000 boats) since 2011, with 139,645 boats registered in Massachusetts in 2011[46]. Additionally, data from the National Marine Manufacturers Association (NMMA) confirms that boat expenditures (including new powerboats, outboard engines, boat trailers, and aftermarket accessories) have increased by 27.4% ($176 million to $224 million) between 2011 and 2014.[47] This supports the contention that, in the last few years, there has been a growth in the boating industry and boating activity in general within Massachusetts.

This growth in boating activity is likely linked to the improving economy within the United States. Between 2007 and 2009, the Great Recession greatly affected the boating industry, causing a steep decline in boat sales.[48] One article notes that the "boating industry was decimated by the recession, largely because sales depend on access to credit, including home equity loans."[49] Now, with the economy improving, boat sales are increasing and the boating industry in general appears to be growing not only within Massachusetts, but the country as a whole.

This recent growth in boating demonstrates the need for safe navigable waterways and accessible channels, docks, moorings, and facilities. Without needed dredging, boating activity—and associated recreational activities such as fishing, swimming, and water-skiing—could be limited. In some areas, this is currently the case, with boaters having to wait for high tide to access a harbor.

[45] The 1990 report does not indicate whether the 224,115 boats included documented vessels.
[46] Starbuck K, Lipsky A. 2013. 2012 Northeast Recreational Boater Survey: A Socioeconomic and Spatial Characterization of Recreational Boating in Coastal and Ocean Waters of the Northeast United States.
[47] National Marine Manufacturers Association. 2015. 2014 Recreational Boating Statistical Abstract.
[48] Barrett, Rick. *Boating Industry Recovers after Sinking during Recession*. Milwaukee Wisconsin Journal Sentinel. 17 January 2014.
[49] Ibid.

Limited access due to dredging needs can have economic implications as well. Limits on transient boaters (e.g., available berthing or limited drafts), losses of slips and moorings, and conversions of fleets to smaller draft vessels, can decrease revenues and spending on goods and services. Owners of larger boats are known to spend more money than smaller boats.

Dredging activity could increase access by opening up new areas to boating activity, decreasing waitlists, and allowing the safe passage of larger vessels. Additionally, in larger commercial ports such as New Bedford and Boston, channel depth can greatly impact the draft of cargo vessels that are able to enter the harbor, which can greatly impact the economy.

C. Safety

Shallow water and insufficient dredging can cause various boating accidents within the United States and Massachusetts. According to the United States Coast Guard's "2014 Recreational Boating Statistics", "groundings" (e.g., boats becoming grounded because of shallow waters or other reasons) ranked number 4 in terms of the ranking of recreational boat accidents within the United States.[50] Massachusetts accounted for 82 of the total 4,064 recreational boating accidents (2%) within the United States in 2014.[51] In 2014, "grounding" accounted for 12 of the 82 total accidents (15%) within Massachusetts (Figure 15).

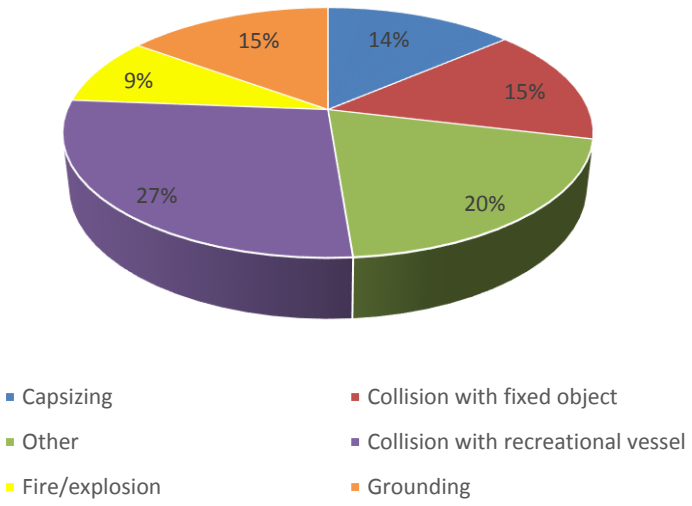

Figure 15. Cause of recreational boating accidents in Massachusetts. (n = 82)

Other includes: Collision with floating object, departed vessel, ejected from vessel, falls overboard, flooding/swamping, and skier mishap.

In addition to causing accidents, shallow water can also impact the ability of a harbormaster, the United States Coast Guard, and other emergency responders to respond to accidents and other marine

[50] U.S. Department of Homeland Security, U.S. Coast Guard, and Office of Auxiliary and Boating Safety. *2014 Recreational Boating Statistics.* May 8, 2015.
[51] Ibid.

emergencies such as oil spills. Furthermore, some shore-side facilities have emergency evacuation plans that are reliant on navigable waters.

CHAPTER 6: CONCLUSIONS

The 2015 State of Our Harbors Survey engaged harbormasters from 68 out of the 73 coastal municipalities within Massachusetts to assess the status of navigation-related dredging within the State. More specifically, this study collected critical information on the dredging needs within Massachusetts, the impacts of dredging activities, and the revenue generated by businesses, the State, and the municipalities through dredging projects. This study also provided an in-depth look at each Massachusetts coastal harbor, describing what makes each harbor unique, and the facilities that depend on those harbors.

Within the state's 204 coastal harbors, harbormasters identified 236 public navigational dredging needs and indicated that at least 115 channels and 32 mooring areas need to be dredged, along with numerous areas around boat ramps, municipality piers, turning basins, and shoal locations ("speed bumps") within harbors. The number of projects per harbor varied, with some harbors having no current dredging needs and others having as many as ten locations in need of dredging.

The following conclusions and recommendations come from the survey, research, and analysis:

(1) The cost of public dredging needs exceeds available resources. Based on the significant need for dredging and associated costs, funding of dredging projects should be a priority for Massachusetts.

The current spending on public dredging projects is insufficient to address dredging needs within Massachusetts. Study results estimate that the cost of needed public dredging projects over the next ten years is approximately $288 million, but that is also likely a gross underestimation given that the cost of one-third of the dredging needs were unknown and could not be estimated, given the variability in dredging costs per project. Currently in Massachusetts, the federal/state government, municipalities, and others are investing, on average, approximately $7.4 million on public navigational dredge projects each year. As such, the dredging needs considerably outweigh the funds available, and entities desperately need additional funding and alternate sources to finance the dredging needs within Massachusetts. Based on the significant need for dredging and associated costs, funding of dredging projects should be a priority for Massachusetts.

(2) The economic importance of ocean-related industries justifies continued investment in dredging

As with all publicly-supported infrastructure, the return–measured in both economic and quality of life terms–far exceeds the cost to the State, municipalities, and all entities engaged in ocean and coastal-dependent commercial and recreational activities in Massachusetts. The estimated tax and fee-related annual revenue generated by the State and municipalities is approximately $237,632,857.

In addition, in 2012, the direct economic contribution of the 1,311 ocean-related businesses in Massachusetts was 19,764 jobs, $1,589,568,277 in wages, and $3,208,348,162 in GDP. While there is not a direct relationship between the investments in dredging and the economic activity of such businesses, these industries are dependent on navigable

waterways maintained by dredging, without which these businesses would certainly suffer some loss in economic activity.

Dredging can have a wide range of impacts on the harbor, the surrounding municipality, the State, and the economy as a whole. If a dredge project is not completed, the harbor could experience a loss of slips/moorings, a limit on vessel draft size, and fewer local/transient vessels, all of which could result in economic losses, as well as create public safety issues. If a dredge project is completed, the harbor could experience an increase in local/transient vessels, water-dependent activities, and boating activity as a whole, which will likely have positive impacts on the economy. An investment in dredging is an investment in the state's economy and should be a priority for Massachusetts.

The State of Our Harbors report provides important information on the status and value of one part of the Commonwealth's transportation infrastructure, and should be updated every 5 years. The design of the study's methodology enables regular updating of the data and findings in support of decision-making regarding investments in dredging and the water-dependent activities along the coastline. The databases and maps of approximate dredged areas and shoreside facilities provide an accessible resource for harbormasters and others to record edits to mapped features, and to update data on dredging needs and dredging accomplished. Future updates to this report will have the advantage of beginning with an existing database of harbors, dredged areas, and facilities. This baseline of information will make it easier for harbormasters to review existing information and provide any necessary updates.

In addition to regular updates of this report, the data provides an important basis for other future research. This study collected a wide array of data that entities could analyze in a variety of ways to answer further questions about dredging activities within Massachusetts. Additionally, the dredging databases from the USACE, Barnstable County dredge, and other organizations have detailed information that filled many data gaps in this study, and entities could continue analyzing these databases to further understanding of the status of dredging within Massachusetts.

In addition to this report, the project produced: 1) a database with information on prior public dredge projects and future public dredging needs; 2) summary pages on each harbor within Massachusetts, including dredging needs, boating facilities, and features unique to each harbor (Appendix A); 3) Arc GIS data layers of boating facilities and approximate dredged areas for the harbors along the coast of Massachusetts. If interested, please contact the Urban Harbors Institute at 617-287-5570 for more details on these products.